NHDOT SPR2 PROGRAM

RESEARCH PROGRESS REPORT

Project # SPR 26962U		**Report Period** Year 2020 ☐Q1 (Jan-Mar) ☐Q2 (Apr-Jun) ☐Q3 (Jul-Sep) XQ4 (Oct-Dec)
Project Title: Improved Practices for Determining the Infiltration Characteristics of Soils for Design of Stormwater BMPs		
Project Investigator: Jean Benoit, PhD **Phone:**		**E-mail:** jean.benoit@unh.edu
Project Start Date: April 17, 2019	**Project End Date:** June 30, 2021	**Project schedule status:** ✓ On schedule ☐ Ahead of schedule ☐ Behind schedule

Brief Project Description:

Soil infiltration data are utilized by the NH Department of Transportation (NHDOT) to assess the suitability of a site for various stormwater best management practices (BMPs) and to properly size and design a treatment area. With the recent issuance of EPA's final Municipal Separate Storm Sewer System (MS4) permit rules, the need for such testing is expected to increase.

In order to estimate infiltration rates, the NHDOT currently utilizes a variation of the borehole infiltration test prescribed in the NH Department of Environmental Services (NHDES) Alteration of Terrain (AoT) rules using conventional geotechnical drilling equipment. Existing testing protocols are labor intensive and time consuming, often taking 4 hours or more to complete a single test interval (depth). This is particularly inefficient if multiple depths require testing, e.g. if the preferred "bottom of practice" has not been established. In addition, the existing test method may not replicate field conditions and is prone to missing important features in the soil profile. Other available tests either require a constant head that is difficult to maintain in the field or have limitations associated with the effective depth of the test or the level of the groundwater table. Research is needed to evaluate alternative methods and improve Department practices to allow for more effective design of BMPs.

A permeafor device, originally developed in France, has been identified as a potential alternative to current practice. The permeafor is an in-situ hydraulic profiling tool that provides a quick estimate of the permeability profile of soil layers and can be adapted to conventional drilling equipment.

The objectives of this research are as follows:

1. Review available permeafor drawings, adapt design features to be compatible with NHDOT equipment and operations, and fabricate a prototype for further evaluation in the field.
2. Compare the performance of the permeafor alongside existing test method.
3. Recommend and implement design modifications as a result of initial testing.
4. Provide a workable permeafor device suitable for implementation on NHDOT projects.

The scope of work for this research includes the following major tasks, with primary responsibility indicated in parentheses:

1. Obtain available permeafor plans, shop drawings, and details. (UNH)
2. Recommend design changes to ensure compatibility with geotechnical drilling equipment operated by the NHDOT. (UNH/NHDOT)
3. Fabricate one or more permeafor devices. A total of two (2) devices are anticipated as part of the research. It is suggested that a single device be fabricated for initial testing and the second device be fabricated to incorporate lessons learned after the initial testing. (UNH)
4. Procure required pumps, flowmeters, and other ancillary equipment. (UNH)
5. Calibrate the permeafor with grain-size analyses and permeability water tests performed in the laboratory. (UNH)
6. Identify field sites for testing. A minimum of three (3) sites will be evaluated, with multiple depths tested at each site. Sites will be chosen where NHDOT-obtained infiltration data has been collected or will be collected during the research. (UNH/NHDOT)
7. Conduct initial field testing at one or two sites. (UNH/NHDOT)
8. Review existing formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)
9. Conduct final field testing at remaining sites. (UNH/NHDOT)

10. Recommend modifications to formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)

11. Provide a final report summarizing the research and containing recommendations for implementation by NHDOT. (UNH)

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

Investigation into determining hydraulic conductivity with data obtained from permeafor testing has continued during Q4. The NHDOT was able to schedule two additional days of testing on the 24th and 25th of November. The test site was located in Rochester, NH, on the southbound side of the Spaulding turnpike (Route 16), next to the Rochester toll booth. During these two days, one SPT and two permeafor profiles were conducted to a depth of twenty feet below ground surface. A total of 16 tests were conducted in these two profiles. The two permeafor profiles were located approximately five feet apart. For all tests, the permeafor probe was equipped with the central 1:1 screen and tests were conducted at similar depths for direct comparison between boreholes. Samples from the SPT were collected for classification and for laboratory hydraulic conductivity testing. Reports on each testing location thus far are progressing and will be incorporated into the final report. Finite element analysis with the use of Plaxis is continuing to investigate water flow from various permeafor configurations into soil formations of varying permeabilities and stratigraphies. This will allow for a better understanding of how flow of water from the permeafor is affected by the surrounding soil conditions and properties. This study will help confirm our estimated hydraulic conductivity values from the various test sites in different soil conditions.

Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc…):

We will need further drilling support at additional test sites to continue our field investigation using the permeafor. We would prefer testing at sites having different geological profiles to expand and explore the capability of the test method. Although we have satisfied the minimum number of sites to be evaluated (3) per Task 6, we would like to include two more sites for training of NHDOT personnel and for broadening the scope of material tested. In addition, for all sites tested to date, borehole infiltration tests would be helpful for comparison to our permeafor results. These borehole infiltration tests should be carried out by NHDOT personnel.

Anticipated research next three (3) months:

With the winter months upon us, we anticipate focusing on laboratory testing and finite element analysis for both the borehole infiltration and permeafor testing methods. We anticipate using the results from these analyses to refine existing empirical relationships for determining hydraulic conductivity from data acquired during permeafor testing. We will also continue to develop sections of the final report.

Circumstances affecting project:

Availability of NHDOT drilling equipment and personnel have been difficult and resulted in less testing than originally anticipated but still within the contract requirements. The results to date are very encouraging but we would like to perform additional testing and, use some of these test days to train NHDOT personnel on how to use the permeafor. At the upcoming TAG meeting we would also like to discuss the construction of the second permeafor probe and support equipment that will best serve the NHDOT.

Tasks (from Work Plan)	**Planned % Complete**	**Actual % Complete**
Task 1: Permeafor plans	*100*	*100*
Task 2: Permeafor – drill rig compatibility	*100*	*100*
Task 3: Permeafor probes construction	*50*	*50*
Task 4: Ancillary equipment purchases and assembly	*50*	*50*
Task 5: Permeability tests in laboratory	*80*	*70*
Task 6: Site selection	*75*	*75*
Task 7: Conduct initial testing	*100*	*100*
Task 8: Review of existing formulas for analysis	*60*	*60*
Task 9: Conduct final testing	*75*	*75*
Task 10: Recommendations	*25*	*25*
Task 11: Final report	*50*	*50*

Barriers or constraints to implementing research results

None